# Low-Carbon Electricity Scenarios for the South: An Assessment of Costs & Options


**NERC Regions in the South**

(NERC=North American Electricity Reliability Corporation)

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# Research Questions

- What are are the likely costs of compliance with the Clean Power Plan in the South and the nation?
- How much do these costs vary across regions in the South?
- What are the least-cost compliance options in the South vs. the nation?
- Would a regional approach to compliance have merit?
- What do our results suggest for choosing between mass- versus rate-based goals?
- What can we deduce about the potential operation of a trading system for carbon emissions credits in the South?

# Methodology

# NEMS is Used to Model CPP's Compliance Costs and Options

- NEMS (National Energy Modeling System) is a general equilibrium model that is used by the U.S. Energy Information Agency to forecast domestic energy trends.
- Geographic resolution for the electricity module: 22 NERC
- "NEMS projects the production, imports, conversion, consumption, and prices of energy, subject to:
  - assumptions on macroeconomic and financial factors,
  - world energy markets,
  - resource availability and costs,
  - behavioral and technological choice criteria,
  - cost and performance characteristics of energy technologies, and demographics."

--Source: EIA 2009 NEMS Overview

# (1) The Cost of Compliance: Estimated with Variable Carbon Fees

- We modify GT-NEMS to model various levels of fees levied on the carbon content of fossil fuels in the electric power sector.
  - Three fees are studied: $10, $20, and $30/metric tons of $CO_2$
  - In 2012 dollars
  - Applied in 2020 and operating through 2040
- The fee needed to achieve a goal is one way to estimate compliance costs.
- NEMS operates with foresight, so changes in response to the carbon fee begin earlier than 2020.

# (2) We Also Updated Solar Costs in the NEMS Model

- LBNL's tracking of solar PV prices* was used to assess solar PV equipment costs in the NEMS Reference Case.
- We use EIA's low-cost renewable side case that assumes 20% lower equipment costs for residential and commercial solar PV compared with the reference case, which is in strong accord with LBNL's projections.
- We reduce NEMS' Reference case costs for utility-scale systems by 36% to reflect LBNL's projections because NEMS estimates are higher.
- These cost reductions are assumed to begin in 2014.

* Source: Barbose et al. (2014) "Tracking the Sun VII: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998-2013, Lawrence Berkeley National Laboratory

# (3) An Integrated Energy-Efficiency Case is also Modeled

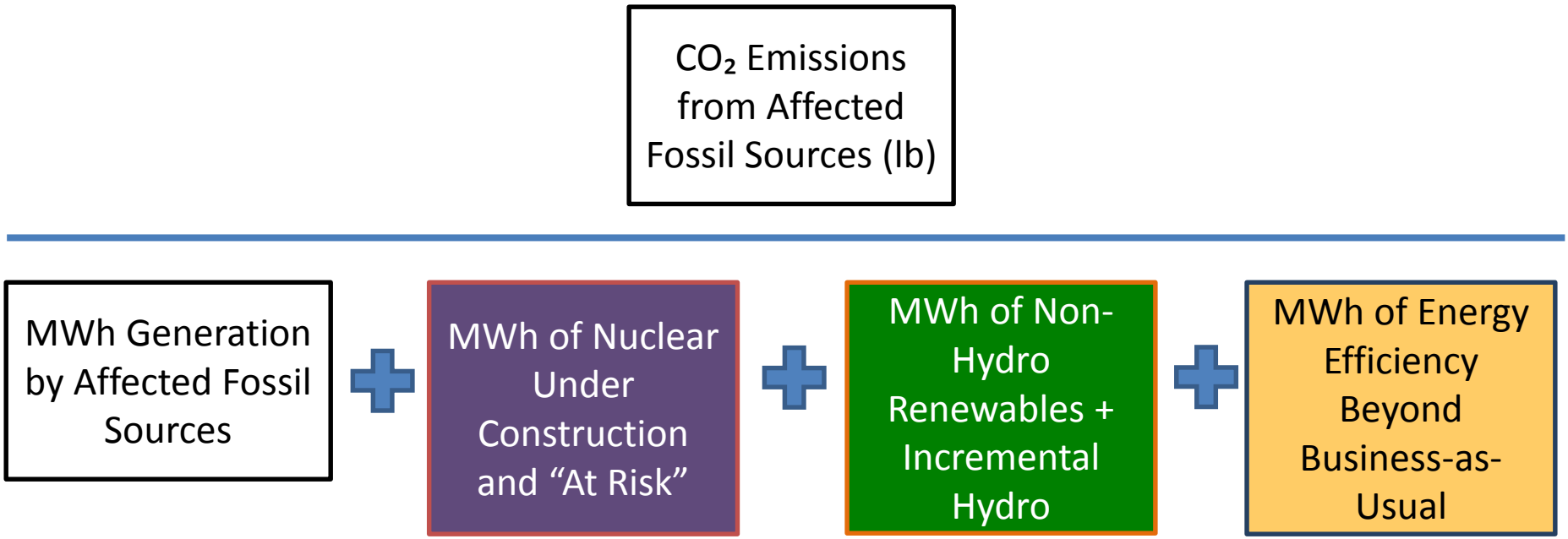
- We employ the assumptions of EIA's High Demand Technology Side Case
  - ✓ Advanced equipment is available earlier, at lower costs, and/or at higher efficiencies
  - ✓ Stricter building codes…
- Stronger appliance and equipment standards
- Lower costs and extended tax credits for industrial CHP
- Increased energy efficiency in five manufacturing sectors
- These changes are introduced throughout the planning period, some beginning in 2014, others later.

Note: For more information: http://cepl.gatech.edu/drupal/node/88

# (4) EPA's Mass- and Rate-based Goals are Averaged for 7 NERC Regions

- Plant-based $CO_2$ emissions data for 2012 are used to weight the state 2030 goals of the Clean Power Plan.
- The proportioning method uses NEMS "EMMDB" data to estimate state-by-state emissions from existing power plants.
- It produces an acceptably small level of deviation from the 2012 $CO_2$ emissions to the EPA's 2012 baseline data and EIA's SEDS state data.

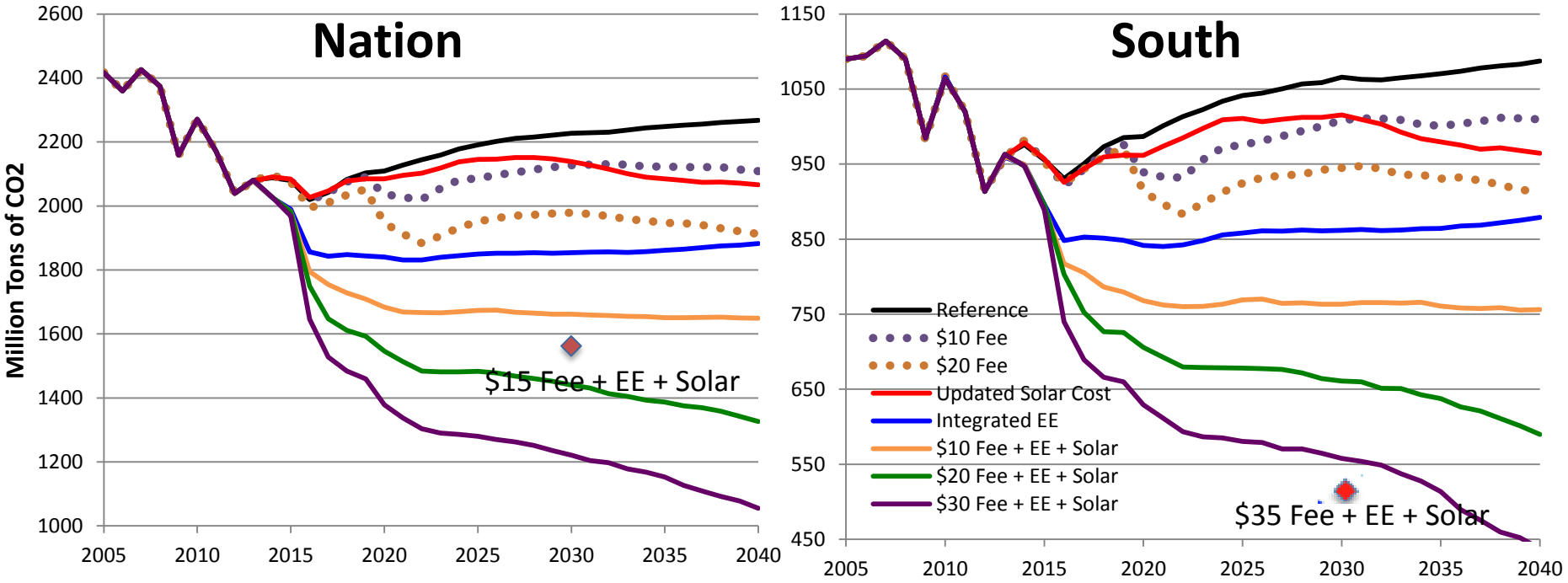
# How Emission Rates Are Calculated



# Regional Results

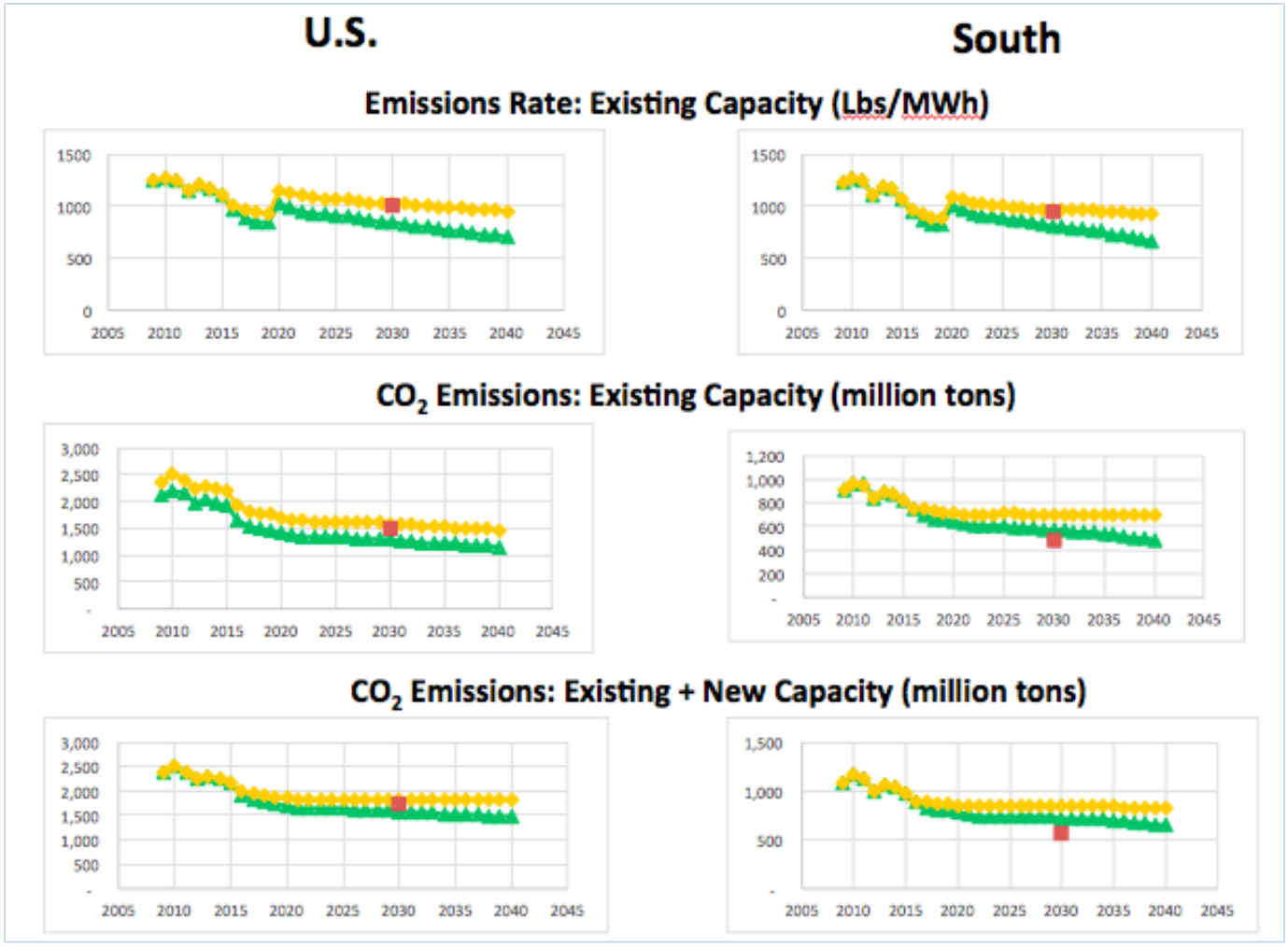
# $CO_2$ Reduction Compliance Costs Appear to be Higher in the South

- National $CO_2$ mass goal for existing + new sources could be met with a $15 Fee + EE + Solar scenario.
- A $35 Fee + EE + Solar approach is needed to meet the average mass goal in the South.




◆ = Mass-based goal for existing affected and new sources

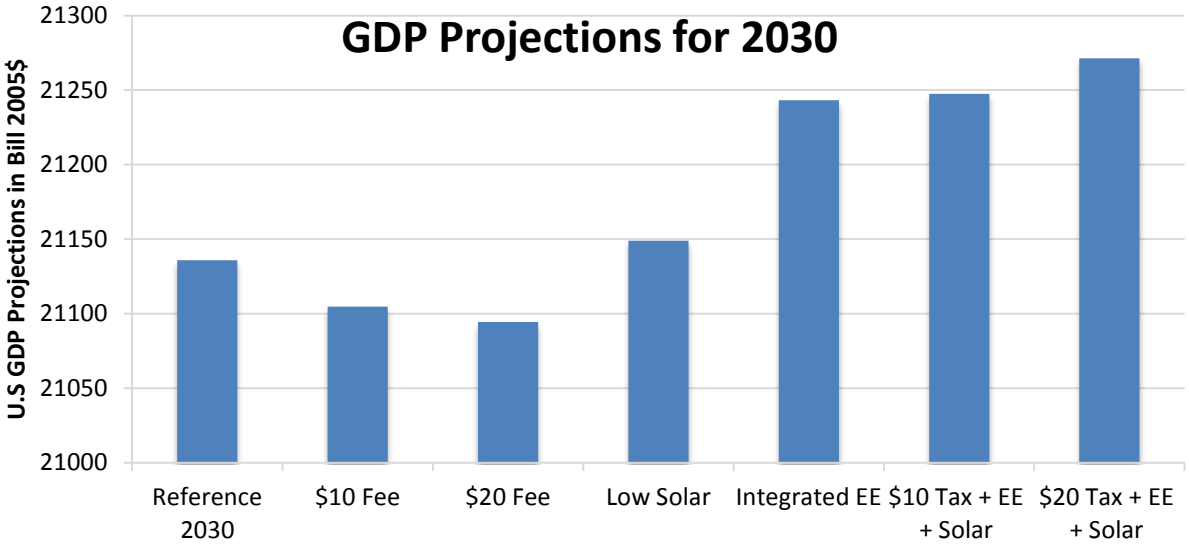
# Rate-Based Goals are Less Costly than Mass-Based Goals in the South

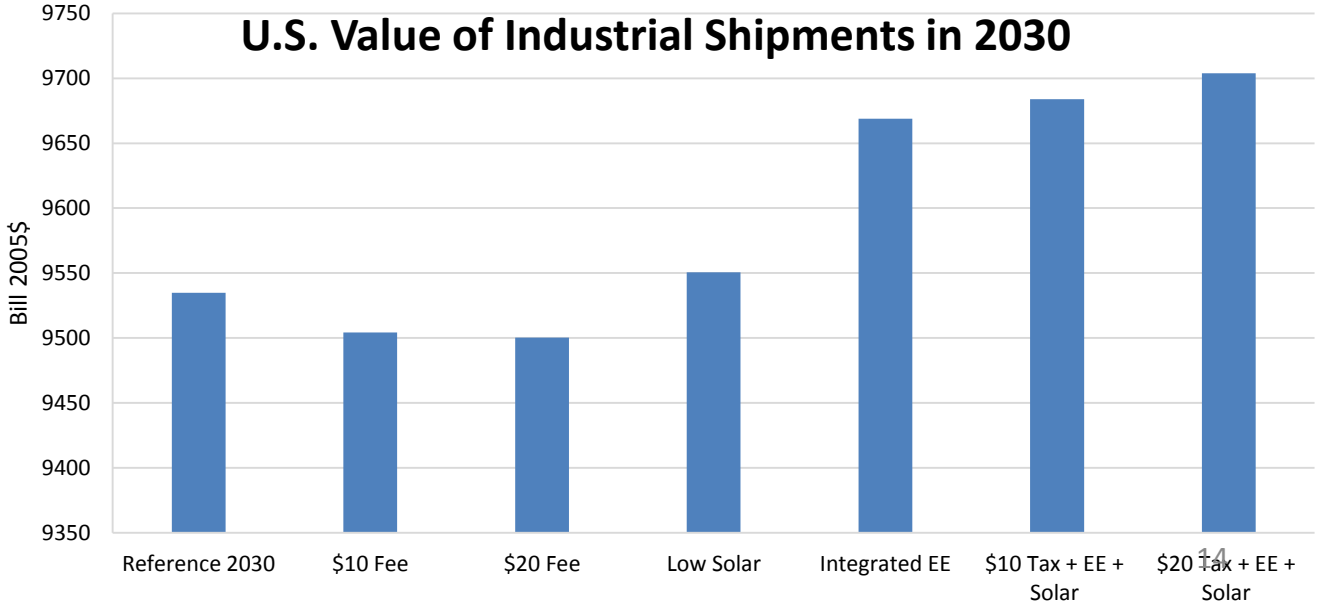


# Mass-Based Goals Appear to be More Difficult to Meet

| Performance with Respect to CPP Goals for 2030 Based on the $20 Fee+EE+Solar Scenario | | Mass-Based Goals (Existing & New Units) | | |
|---|---|---|---|---|
| | | Region Falls Short | Region Meets | Region Exceeds |
| **Rate-Based Goals (Existing Units Only)** | Exceeds | SRVC | | **"The Nation** |
| | Meets | **"The South"** SRSE, SRDA, SRCE, | | FRCC, SPPS |
| | Falls Short | TRE | | |

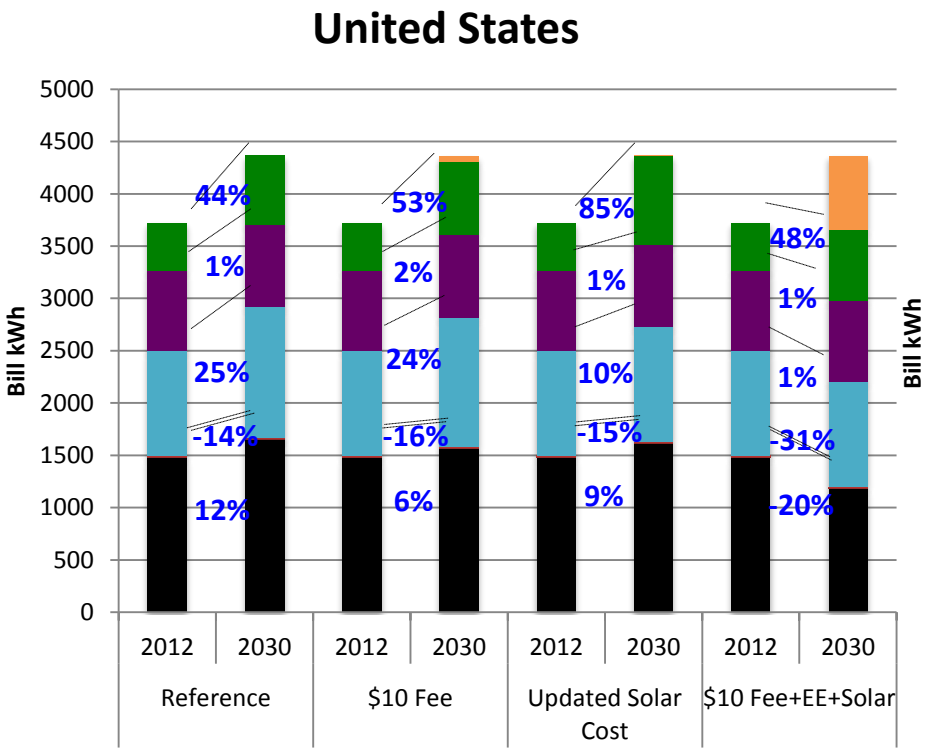
# GDP: Shrinks with Carbon Fee; Grows with EE and Updated Solar Costs

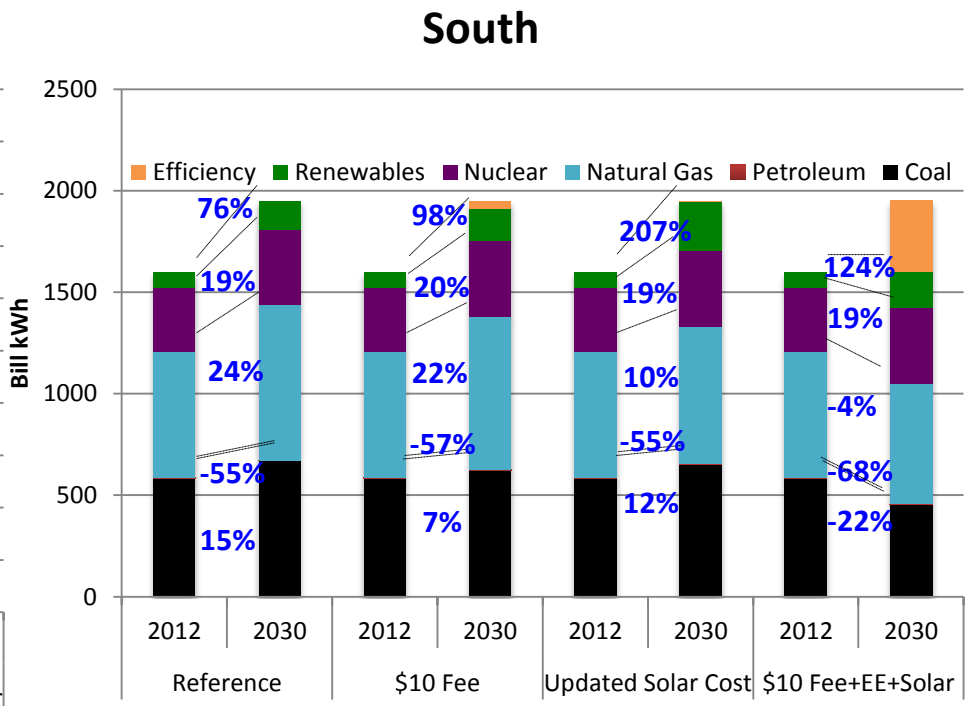


# What are the Least-Cost Carbon Reduction Options: U.S. vs South?

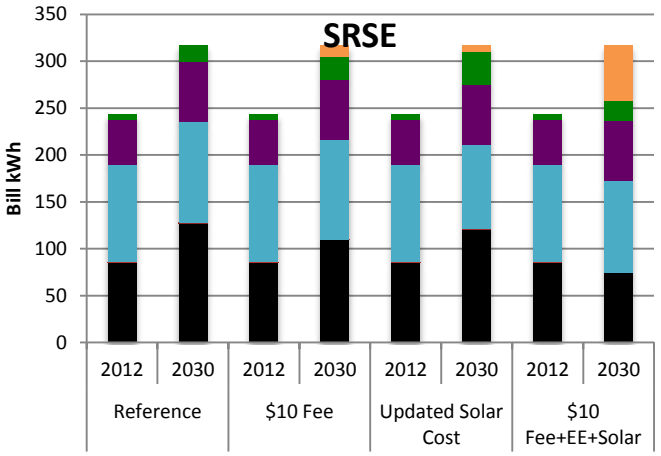
- In the $10Fee + EE + Solar scenario:
  - ✓ EE, natural gas and renewable energy would grow
  - ✓ Renewable energy and nuclear would expand more in the South than the U.S.
  - ✓ Coal would decline rather than expand

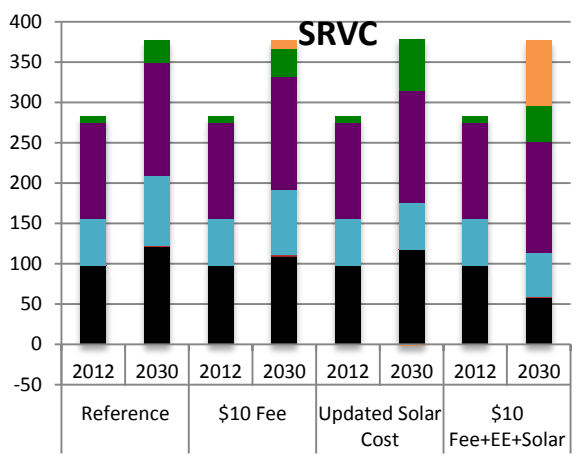


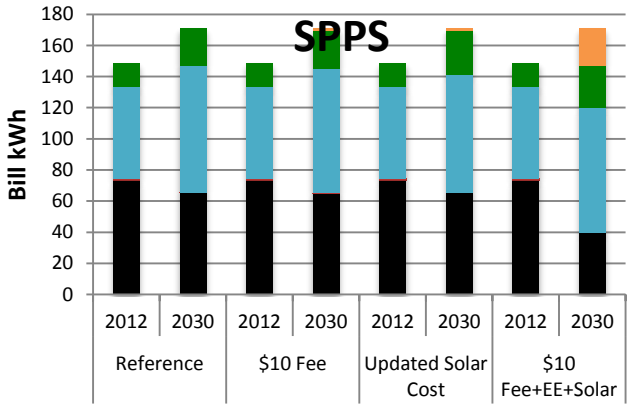
With a $10 Fee + EE + Solar:

- EE grows in all regions
- SRCE & SRVC: Nuclear displaces coal; NG & RE grow
- SRDA & SRSE: RE displaces coal and nuclear is steady
- FRCC: Nuclear & RE displaces coal and NG.
- TRE: RE grows
- SPSS: RE & NG displace coal

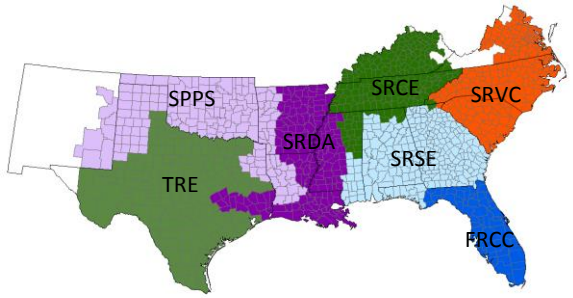


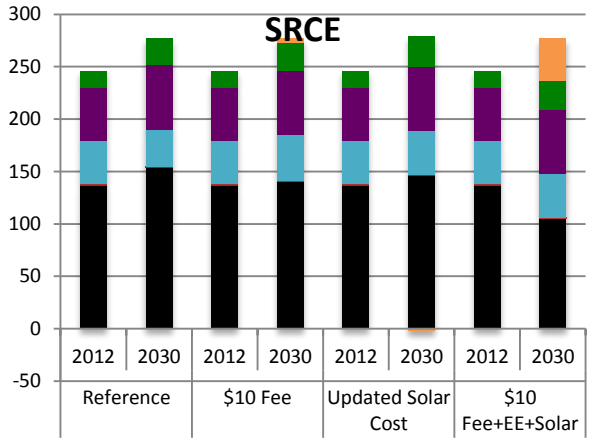



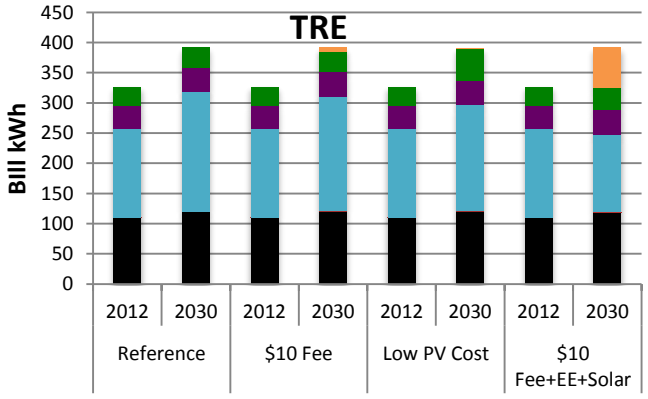

Efficiency Renewables Nuclear Natural Gas Petroleum Coal

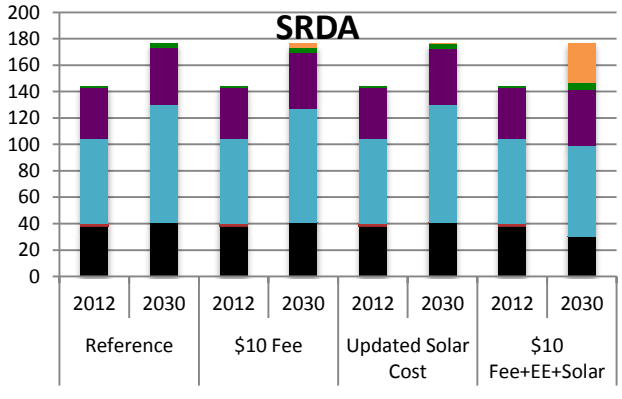


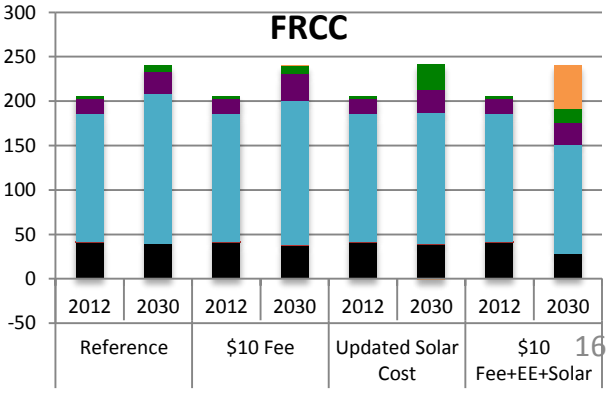

**Fuel Changes by NERC Region (Bill kWh)**



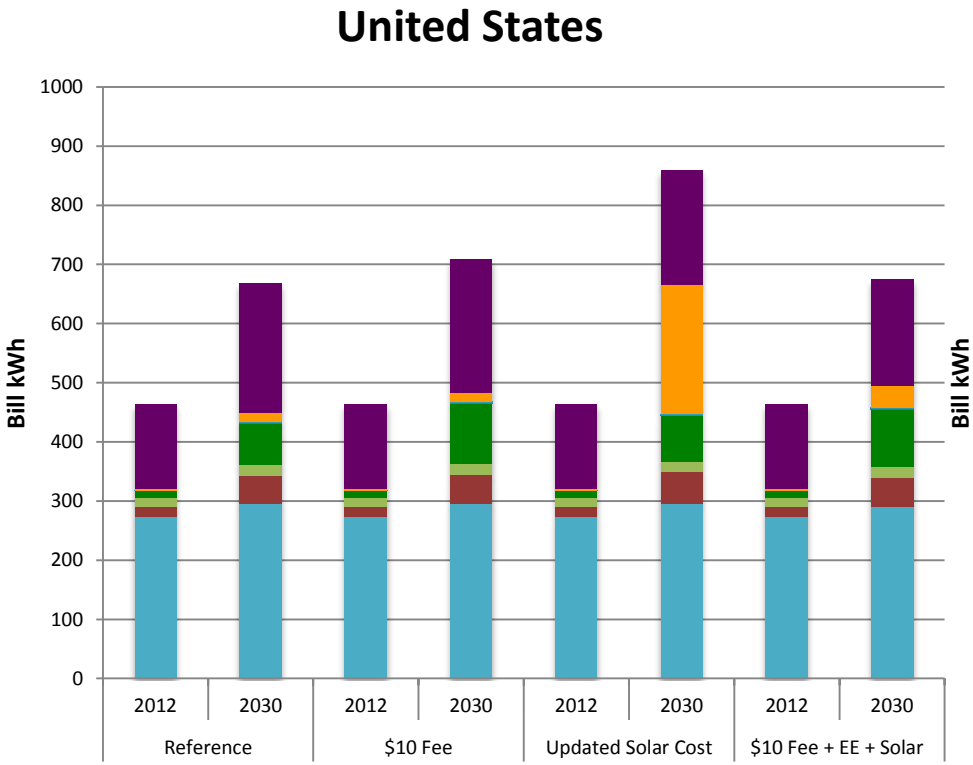



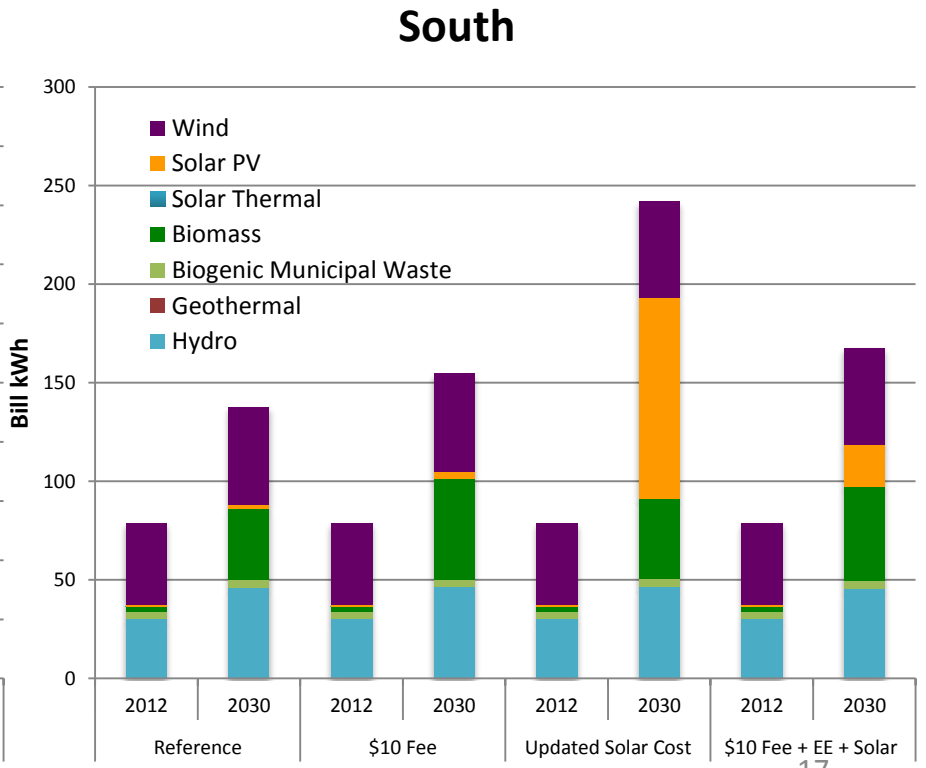



# Least-Cost Renewable Energy Options Vary Across Regions

- Nation: solar PV, biomass, geothermal, and wind would grow significantly
- South: solar PV and biomass would grow significantly (hydro slightly)

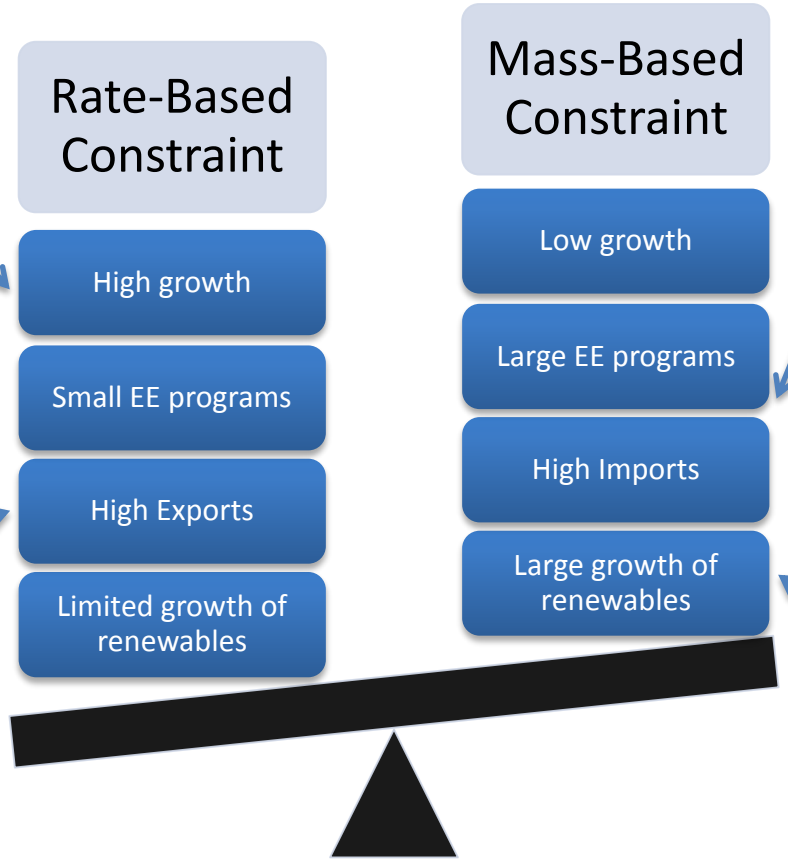


# Mass- Versus Rate-Based Goals: Some Preliminary Thoughts

High growth could lead to new natural gas capacity and hence more $CO_2$ emissions, which would put pressure on the state's mass goal; rates would be better.

High exports of fossil-based power would penalize the source state for associated emissions; therefore rates would be better.




Large EE programs will offset mass emissions, but may not improve rates if reductions are balanced across the portfolio; therefore mass goals would be better.

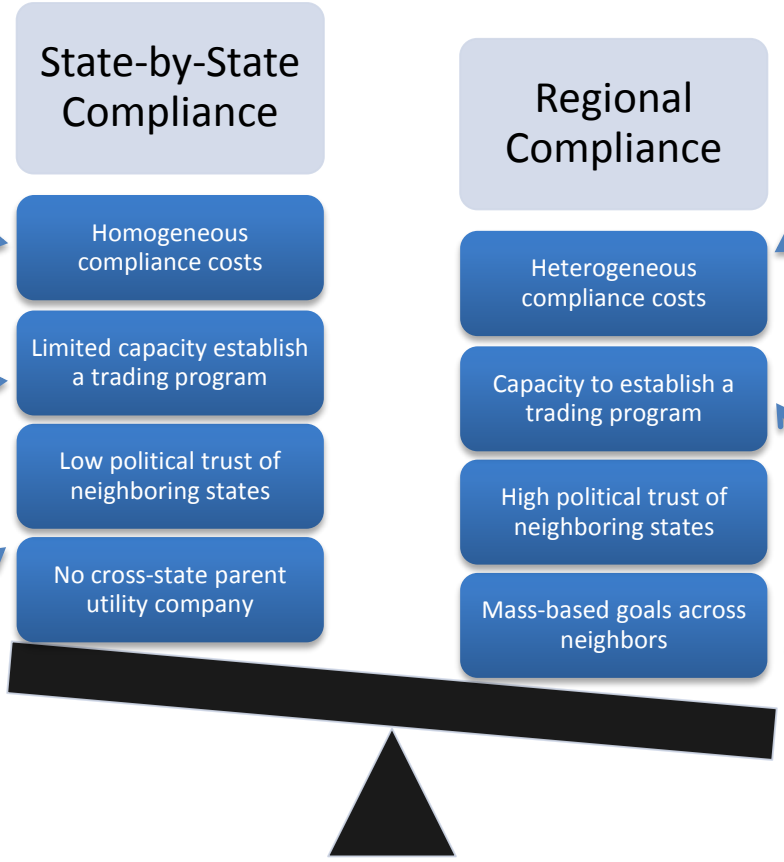
A large addition of new clean energy would likely displace fossil power and therefore reduce mass emissions.

# State-by-State vs Regional Compliance Approach: Some More Preliminary Thoughts

If compliance costs are similar across states, the motivation to trade is reduced.

No excess clean capacity and little experience to expand it quickly would lead to state approach.

Trading requires some minimal level of trust; more challenging without a cross-state parent company.




Heterogeneous compliance costs mean there is an opportunity for efficiency gains through cross-state trading.

Trading systems and regional accords require legal & other capabilities, facilitated by cross-state parent company.

To date, carbon trading programs have mostly been mass-based.

# For More Information*

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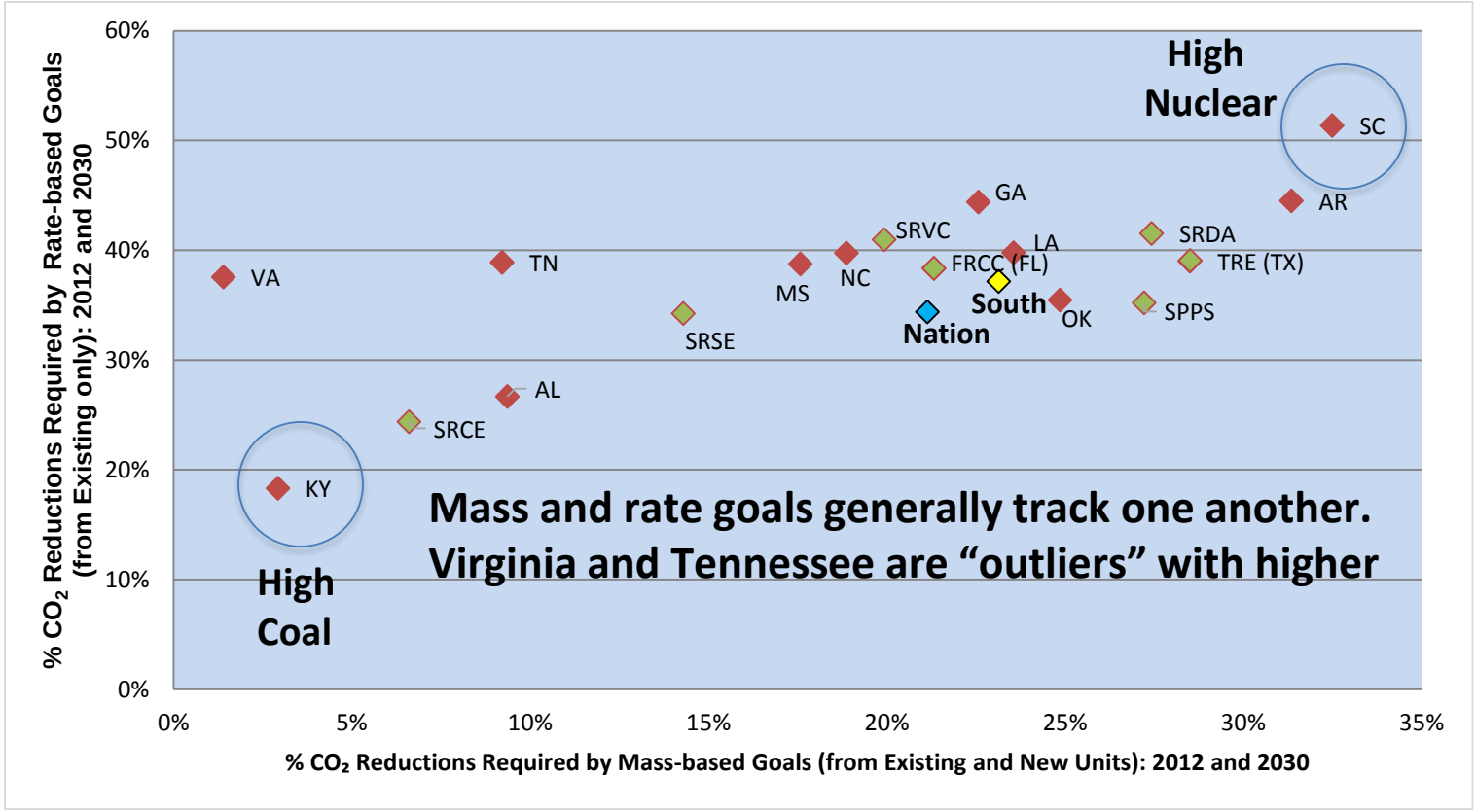
# Comparison of Mass- and Rate-Based $CO_2$ Reduction Goals




Sources: 2012 Emissions - EPA State CO2 Emissions, http://epa.gov/statelocalclimate; 2030 Goals - EPA Fact Sheet, http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-technical-support-document#print